(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: 0 295 774 A2

(12) EUROPEAN PATENT APPLICATION

(21) Application number: 88303769.9

(51) Int. Cl.4: B02B 3/00

(22) Date of filing: 27.04.88

(30) Priority: 18.06.87 US 64067

(43) Date of publication of application:
21.12.88 Bulletin 88/51

(84) Designated Contracting States:
AT BE CH DE ES FR GB GR IT LI LU NL SE

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(54) Method and apparatus for the treatment of wheat kernels.

(57) Significant improvements to the milling of wheat kernels are possible by sequentially removing the bran layers of the kernels prior to processing in general accordance with conventional milling principles. The wheat kernels are preprocessed by means of a number of friction and abrasion operations to peel or strip the various layers of bran from the kernels. A series of friction machines (208,215,218) followed by abrasion machines (224,230) progressively remove the bran layers and separate the same into generally pre-identified bran layer mixtures. Up to about 75% of the bran can be removed with the remaining bran being essentially confined to the kernel crease and removed during the conventional milling operation. Such preprocessed kernels, when milled in the conventional manner, have higher yields due to less bran contamination. This selective removal of the bran layers also facilitates low cost production of speciality bran products or selective reintroduction of bran layers to flour after, or during, further milling.

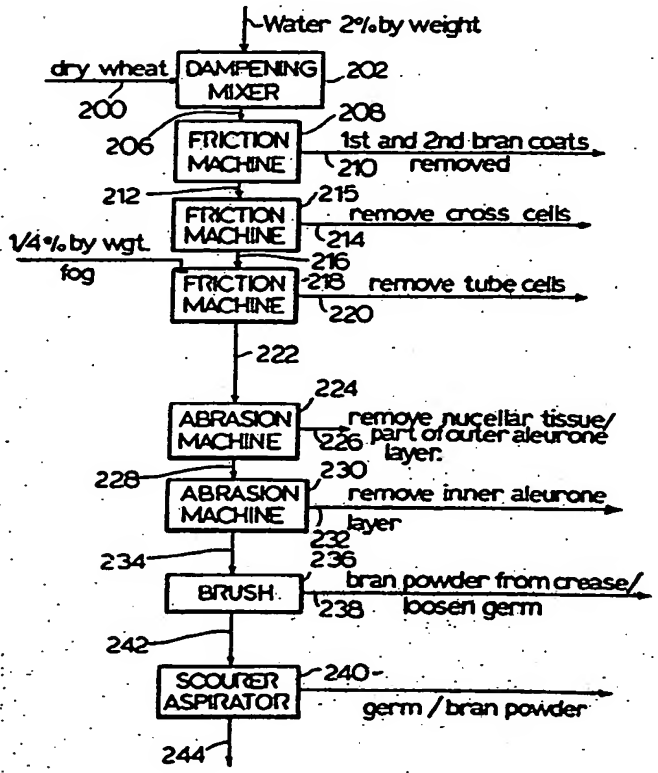


FIG.1.

EP 0 295 774 A2

"METHOD AND APPARATUS FOR THE TREATMENT OF WHEAT KERNELS"

The present invention relates to a method and apparatus for the treatment of wheat kernels for use in the milling of flour. In particular, the invention relates to a method and apparatus for the milling of flour which subjects the wheat kernels to additional process steps prior to subjecting the wheat kernels to the traditional tempering operation in preparation for milling.

The general objective of the milling process is to extract from the wheat kernel the maximum amount of endosperm in the purest form. This requires the efficient separation of the components of the wheat kernels, namely the bran, endosperm and germ. Bran and germ have a detrimental effect on the end millec products, flour or semolina for pasta production.

In the conventional milling process, after the initial cleaning steps, the wheat kernels are conditioned with water and/or steam and allowed to rest in temper bins for 4 to 20 hours (tempering) to toughen the bran coats of the wheat kernels and soften or mellow the endosperm. Tempering of the wheat kernels fuses the bran coats together and is an essential conditioning step of the kernels carried out prior to the conventional milling process to alter the physical state of the kernels in a desired manner. This preparation or change of the physical state of the kernels is undoubtedly the most important factor in determining the amount of endosperm produced from given wheat kernels and, therefore, great care is taken to appropriately alter the kernels prior to milling.

The tempering of the wheat kernels to toughen and fuse the bran coats, unfortunately, also causes some fusion of the endosperm to the inner layers of bran whereby separation of these components is more difficult. The conditioned kernels are then subjected to successive stages, each of which grind, separate and purify the product. The first grinding operation open the tempered kernels to expose the endosperm and scrape a portion of the endosperm from the bran. The coarsely ground mixture of bran, germ and endosperm particles is then sifted to classify the particles for further grinding, purification or sifting. The finer classified particles, which are a mixture of endosperm, bran and germ are then sent to the appropriate purification steps. The coarse remainder, consisting of bran and adhering endosperm, is sent to the next grinding step to remove more of the endosperm from the bran. The breaking process is repeated up to 5 times in a conventional mill. However, each grinding process produces fine bran particles (bran powder) and germ particles which have a tendency to be separated with the endosperm and are difficult, if not impossible, to remove from the endosperm. Each grinding operation produces more and more bran powder, compounding the problem.

Effective removal of the bran from the endosperm remains a problem, which affects the yield possible from given wheat kernels as well as the fixed capital cost of a mill and the variable costs for milling high grade patent flour, and/or semolina.

According to the present invention the wheat kernels are pre-processed to effectively remove the bran coat layers sequentially by passing them through various friction based operations followed by abrasion operations which peel, strip or otherwise remove the bran layers from the wheat kernels while the endosperm remains essentially integral. In contrast to the conventional practice, the wheat kernels, processed according to the present process, are not subjected to tempering initially, as this would fuse the various bran layers. The kernels are processed to effectively strip these bran layers from the endosperm prior to tempering of wheat kernels. The initial four layers of the bran coating are removed preferably by initially conditioning the outer bran layers with a small amount of water, normally less than 2% by weight. This water does not fuse the entire bran coating, but merely serves to condition the outer layers. Timing between applying the water and stripping the layers is important and the wheat kernels are processed essentially immediately in contrast to the required several to many hours for tempering. The conditioned kernels are passed through a friction machine to remove the outer bran layers. The friction operations for stripping of the bran layers, in some cases, can be enhanced by fogging of the remaining wheat kernels prior to processing in the last friction type operation. Fogging of the kernels is not to be confused with a tempering operation. Tempering fuses the various bran layers such that sequential removal of the individual layers is not possible, fogging only adds moisture which enhances separation of the layers. Abrasive operations follow the friction operations and are required to remove the nucellar layer and aleurone layers which tend to polish in friction apparatus.

It should be recognized that the above process for sequentially removing the bran layers will not be 100 percent effective, however the pre-processed kernels will have most of the bran coating removed and as such, the difficulties with respect to bran contamination and separation of the various desired components of the wheat kernel is greatly reduced. This allows the downstream processes of conventional milling to be simplified and/or more

effective. All the bran coating is not removed by the present process as the bran within the crease, for the most part, remains intact A further advantage is found in that the friction and abrasion operations can be adjusted to strip various portions of the bran layers. These portions have unique properties and can be processed to produce a product of increased value. Many advantages can be obtained by preprocessing the kernels sufficiently to remove the seed coat, which is a major factor in the colour contamination of the patent flour.

In order that the invention may be better understood several embodiments thereof will now be described by way of example only and with reference to the accompanying drawings in which:-

Figure 1 is a flow chart showing the various steps used in advance of the normal milling process;

Figure 2 is a perspective view of the wheat kernel with a portion of the layers cut away;

Figure 3 is a cross-section taken through a wheat kernel;

Figure 4 is a sectional view of a friction machine;

Figure 5 is an end section of the friction machine of Figure 4;

Figure 6 is a sectional view of an abrasion machine; and

Figure 7 is an end section of the abrasion machine.

Referring to the drawings the wheat kernel 2, generally shown in Figures 2 and 3, has a bran coating 4 made up of a host of different layers identified as 10 through 20. Interior to the bran coat is the endosperm 6 with the wheat germ generally identified as 8. In general, the bran layers collectively make up about 15% of the wheat kernel, whereas the germ represents about 2.5% and the endosperm represents about 83%.

The layers of bran from the outer to inner layer are:

epidermis 20
hypodermis 16
cross cells 14
tube cells 12
seed coat 11
nucellar tissue 10
alleurone cells 9

In the cross-section of Figure 3, a portion 5 of the seed coat 11 is located within the crease 7 of the wheat kernel 2. It should be noted that the bran layers do extend within the crease 7 and this bran is left substantially intact to be removed subsequently by the milling technique.

The alleurone layer is quite thick and acts as a tolerance zone for the last abrasion operation. It is desirable to leave some of the alleurone layer to thereby ensure the maximum amount of endosperm to be processed and thus maximize the yield.

The wheat kernel 2 generally shown in Fig. 2 is illustrated with the various layers of the bran partially peeled on the left side of the kernel and, the present process, seeks to peel away or remove these layers. It has been found that the use of a series of friction operations followed by a series of abrasion operations applied to the kernels prior to the tempering of the kernels will allow various layers of the bran coating 4 to be sequentially removed and separated from the wheat kernels. It is not essential that each layer be removed independently of an underlying layer and, in fact, the operations are such that often two layers are removed or partially removed at the same time. In effectively stripping or peeling of these layers from the wheat kernels, some of the underlying layer may also separate and therefore, although the operation as described with respect to the flow chart of Fig. 1 discusses removal of particular layers, some portions of other layers may also be removed.

The process for removing the bran layers is generally shown in Fig. 1. This process is upstream of the traditional milling process and, in particular, in advance of the tempering of the wheat kernels. Traditional steps for removing debris, dirt, etc. have already been completed. The process begins by placing the dry, generally clean wheat kernels indicated as 200 into a dampening mixer 202 and adding water 204 in an amount equalling about 2% by weight of the kernels. The mixer serves to ensure the kernels are fully brought into contact with the water and the outer layers of the bran coat effectively absorb most of the water. The water penetrates to about the nucellar tissue layer 10 which repels the water to a certain extent, due to its higher fat content. The repelled water serves to part the layers to assist in removal by friction. The kernels are moved within 15 to 60 seconds from the dampening mixer 202 to a friction machine 208 which brings the kernels into friction contact with one another as well as friction contact with the machine or various moving surfaces of the machine. The movement of the kernels from the dampening mixer 202 to the friction machine is indicated by arrow 206. The friction machine 208 effectively strips the outer bran layers, namely the epidermis 20, the hypodermis 16, and some of the cross cells 14. These layers are removed from, or separated from, the remaining kernels and are discharged from the friction machine along the line indicated as 210. The partially processed kernels are then transported, as indicated by line 212, to a second friction machine 215 which removes the remaining cross cells 14, the tube cells 12 and

most of the seed coat 11. These removed layers are separated from the kernels as indicated by line 214, with the processed kernels being passed to a third friction machine 218 as indicated by line 216.

Friction machine 218 takes the processed kernels and removes the remaining seed coat 11 and a portion of the nucellar tissue layer 10. Optionally, a fogging of the kernels can be introduced in the friction machine 218 which may assist in separating of some of the layers. These removed layers are again separated from the kernels as indicated by line 220, with the kernels being further transported, as indicated by 222, to the first abrasion machine 224. Abrasion machine 224 removes the remaining nucellar layer and most of the outer alleurone cells 9 which are discharged as indicated by line 226. The stripped kernels are passed, as indicated by 228, to a further abrasion machine 230 which removes the inner aleurone layer. The separated aleurone layer is removed as indicated by line 232.

At this point, the bran coating has been substantially removed from the wheat kernels other than in the crease area and the preprocessed kernels are moved, as indicated by line 234, to the brushing apparatus indicated as 236. This brushing operation removes bran powder from the crease of the wheat kernels and serves to loosen the germ of the wheat kernels. Bran powder is removed as indicated by line 238 with the resulting kernel, which now is essentially the endosperm and germ being passed from the brush apparatus 236 to a combined impact and scour aspirator 240 along the line 242. The combined impact and scour aspirator 240 serves to remove most of the germ before tempering and also removes further bran powder. The kernels which leave the aspirator 240 as indicated by line 244 can now be processed in a more or less conventional manner in that most of the bran coating has been removed and most of the germ has been removed. This product may now be conditioned and tempered and passed through the milling process. The tempering can take less time and less grinding, separating and purifying steps will be required to achieve the same or higher degree of flour purity.

According to the process, the germ and endosperm, and particularly the endosperm, remain integral during removal of the bran coats. The preprocessing steps are carried out before tempering of the kernels which would have fused the bran layers and mellowed the endosperm. The non-tempered endosperm is somewhat hard and acts as an interior support for the friction and abrasion operations.

Although three friction machines are shown and two abrasion machines are shown for separating the various bran layers, some of these operations can be combined if a lesser degree of separation of individual bran layers is desired or more machines may be provided if greater control is warranted.

One friction-type machine 100 for removing bran layers is shown in Figure 4, having a hopper 102 for receiving the wheat kernels to be processed. The received wheat kernels are advanced by the screw feed 104 along the axis of the machine to a bran removing section 106. A mill roll 108 is carried on hollow shaft 110 and causes the wheat kernels to be in friction contact with each other or friction contact with the mill roll 108 or the outer screen 112. The mill roll 108 causes the kernels to move rotationally about the axis of the hollow shaft 110 as they are advanced through the length of the machine. The wheat kernels are discharged from the machine at the discharge chute 114 having a control member 116 for varying the output rate. The control member 116 is adjusted by the lever and weight arrangement 118. By increasing or decreasing the force exerted on said control member 116 by means of the lever and weight arrangement 118, a greater or lesser back pressure can be created and this allows control of the amount of bran removed as it is processed through the machine. The mill roll 108 cooperates with the outwardly disposed screen 120 which is appropriately sized to allow removed bran to pass therethrough. To encourage bran to pass through the screen 120, air is introduced to the hollow shaft at 122 and passes along the hollow shaft to the mill roll 108. The mill roll 108 has many vent holes 124 along its length and the air passing therethrough makes its way through the wheat kernels carrying removed bran to and through the screen. The bran is collected and suitably discharged from the machine separately.

The mill roll 108 and screen 112 are shown in vertical cross-section in Figure 5.

The abrasion machine 150 of Figure 6 and 7 is similar to the friction machine 100, however, in this case, an abrasive roller 152 cooperates with an outer concentrically disposed perforated steel cylinder 154. The abrasive roller 152 includes a certain pitch thread for advancing the kernels as well as an abrasive grit surface. These characteristics can be adjusted, for example by having various abrasive rollers, to vary the action exerted on the kernels as they pass through the machine. The machine includes an intake hopper 156 for receiving the partially processed wheat kernels, and the processed kernels are discharged at chute 158. Again, a control member 160 varies the opening of the discharge chute to thereby vary the back pressure. Adjustment is made by means of the lever arm and weight arrangement 162. Air under pressure passes through the hollow shaft 164 and is axially discharged through the abrasive roller 152

to cool the wheat kernels and urge removed bran coats to pass through the perforated steel cylinder 154. The air also serves to clean the kernels of small bran particles. The removed bran layers or layer pass through the perforated steel cylinder, collect in cavity 161, and are discharged separately.

Both friction and abrasion machines preferably can be adjusted to provide satisfactory control of the bran layers removed, irregardless of the size of the kernels. Total control of the bran layers removed in each step is not required, however effective control of the last abrasion operation can increase the yield by assuring the endosperm remains essentially intact.

Both friction and abrasion machines utilize the non-tempered endosperm as an internal support for stripping the bran from the kernels. This approach is in direct contradiction to the use of grinding apparatus in the conventional process which not only breaks the fused bran coat, but also breaks the endosperm. This results in a host of fragments of bran, germ and endosperm which essentially must be commonly processed in an effort to efficiently separate the endosperm immediately underlying the bran from the bran. This is a very difficult problem as it requires further grinding or breaking of the fragments, which in turn creates more bran powder which is extremely difficult to remove from the powdered endosperm.

These problems are substantially reduced with the present process since approximately 75% of the bran has been removed.

In the milling of certain high fibre flour, some of the removed bran layers may be added back after the endosperm has been milled into flour. This will allow a greater degree of accuracy with respect to the actual type of fibres in the flour and the amount thereof.

The present process, if desired, could be completed as a separate step and the processed kernels stored for later milling. Also, the processed kernels can be reintroduced to any of the friction and abrasion operations if for some reason they are not satisfactory. These advantages of partially processing the kernels and/or the ability to reprocess certain operations of the new milling process add flexibility in a system which previously was essentially inflexible.

The process as generally indicated in Fig. 1 is designed to allow separation of the bran layers in a sequential manner where the separated bran layers, if desired, can be used for specialized products. This separation cannot be accomplished with the conventional process in that the bran layers have been fused. By sequentially removing and separating the bran layers, more specialized and profitable products can be produced. Therefore, not only is the separating of the bran layers important with respect to milling of the endosperm, it is also important as valuable by-products are created.

Advantages of the present process and apparatus include:

a) Purer/cleaner flour as bran and/or germ contamination has been reduced;

b) Reduced capital expense as the number of stages required grinding, separating and purifying is reduced;

c) Opportunity to increase throughput of existing mill using preprocessed kernels;

d) Higher endosperm extraction rates;

e) Reduced process steps for given yield;

f) Reduced technical skills for carrying out the process; and

g) Substantially increased flexibility in processing the kernels to improve extraction rate by adjusting preprocessing equipment and/or repeating certain preprocess steps.

The method steps and apparatus therefor, have been described in the preferred embodiment where the bran layers are stripped to expose the endosperm or where the bran layers have been removed with a portion of the alleurone cells remaining to maximize the yield of endosperm.

Claims

1. In a process for treating of wheat kernels having a bran coat, an endosperm and a germ, the improvement comprising processing the wheat kernels to initially substantially remove the bran coat from the endosperm in advance of tempering of the wheat kernels, said wheat kernels being processed by applying an amount of water to the wheat kernels for a time sufficient to condition only an outer portion of the bran coat, and thereafter immediately passing said conditioned kernels through friction operations to substantially remove the outer bran coats; and further processing the kernels to subsequently substantially remove the remaining bran portion by passing the kernels through abrasion operations which remove an inner bran portion while maintaining the endosperm essentially integral in preparation for processing of the endosperm.

2. In a process as claimed in Claim 1, wherein said conditioning amount of water is about 2% by weight and said conditioned kernels within about 15 seconds to 60 seconds are subject to the friction operations.

3. In a process as claimed in Claim 1 or 2, wherein at least 70 to 80 percent of said bran coat is removed prior to processing of the endosperm.

4. In a process as claimed in Claim 2, wherein after removal of the bran coat, the endosperm and germ are subject to operations to remove the germ by impaction.

5. A flour milling process comprising:

conditioning the wheat kernels with water in an amount equal to about 2% by weight for a time sufficient to allow the water to penetrate into the bran layers without fusing the layers together and leaving the endosperm of the kernels at least substantially unaffected;

subjecting the conditioned kernels to a series of friction like operations followed by abrasion operations to remove a major portion of said bran layers;

separating the removed bran layers from the remaining portion of the kernels, and thereafter processing the remaining portion of the kernels.

6. A process as claimed in Claim 5, wherein said step of conditioning the wheat kernels is for a time from about 15 seconds to one minute and then immediately subjecting the conditioned kernels to the series of friction like operations which include means for separating the removed bran layers from the processed wheat kernels.

7. A process as claimed in Claim 5, wherein said series of friction like operations initially removes the epidermis and hypodermis layers of bran and separates the removed layers from the wheat kernels whereafter the remaining portion of the wheat kernels are subject to further friction like operations and the following abrasion operations to progressively remove the remaining layers of bran.

8. A process as claimed in Claim 7, wherein said remaining layers of bran including cross cells, tube cells, seed coat, nucellar layer and aleurone are progressively removed by substantial removal of

the cross cells and tube cells, followed by removal of

the seed coat in a friction or abrasion operation, followed by abrasive removal of

the nucellar tissue and at least part of the aleurone layer.

9. A process as claimed in Claim 8, wherein the additional step of fogging with an amount of water is added prior to removal of the step which removes the seed coat.

10. A process as claimed in Claim 8, including separately removing and storing the removed layers after each friction like operation.

11. A process as claimed in Claim 10, wherein processing the remaining portion of kernels includes subjecting the kernels to a brushing operation to remove residual bran powder and loosen the germ.

12. A process as claimed in Claim 11 including the additional step of impact scouring the kernels to remove the germ and aspirate any remaining bran powder.

13. A process as claimed in Claim 11 or 12, wherein the processed kernels comprising essentially endosperm are mixed with water to bring moisture of the endosperm to the desired level, followed by tempering for up to 16 hours, followed by milling thereof.

14. A process for removal of the bran coat from wheat kernels comprising dampening the clean, dry wheat kernels and then subjecting the kernels to a series of friction and abrasion operations, to sequentially remove predetermined layers of the bran coat.

15. The process of Claim 14, wherein the removed layers of the bran coat include removal of the seed coat.

16. A process for removing the bran coat from wheat kernels comprising the steps of:

(a) adding water to clean, dry wheat in a dampening mixer;

(b) permitting the dampened wheat to stand 15 to 60 seconds;

(c) passing the dampened wheat through friction means to remove the outer layers of the bran coat;

(d) separating the removed bran coat from the remaining portion of the wheat kernels;

(e) passing the remaining portion of the wheat kernels through further friction means and subsequent abrasion means to sequentially remove the remaining layers of bran, and:

(f) separating the layers of bran removed in step (e) from the remaining portion of the kernels.

17. A process for milling flour comprising passing wheat kernels through a number of operations, said process comprising

applying an amount of water to the kernels to condition the outer layers of bran while at least essentially maintaining the endosperm protected from the water,

processing said conditioned kernels by means of friction operations to remove said outer layers of bran, followed by

a series of friction and abrasion operations which strip at least a major portion of the remaining bran from said endosperm and germ,

whereafter the remaining portion of the kernels can be processed in a conventional manner including tempering the kernels with water.

18. In a process for milling flour, the improvement comprising removing a majority of the bran coat and the germ before tempering of the kernels by means of a series of friction and abrasion operations to strip the bran coat, and removing the

same from the endosperm and germ, followed by substantial removal of the germ from the endosperm.

19. In apparatus for milling flour, a series of friction applying means and a series of abrasion applying means upstream of the means for tempering of the kernels, said combined series of friction and abrasion applying means progressively removing at least about three quarters of the bran coat prior to tempering, said friction and abrasion applying means including means for separating the removed bran from the remaining portion of the kernels.

20. Apparatus for preprocessing of wheat kernels to remove a majority of the bran coat while maintaining the endosperm generally integral comprising a series of friction apparatus which generally sequentially strip bran layers of the wheat kernels starting with the outer layers and working towards interior layers of bran, said series of friction apparatus removing bran layers to at least expose most of a seed coat of wheat kernels,

and a series of abrasion apparatus to continue the sequential stripping of the bran layers terminating in substantial removal of alleurone cells of the bran layers.

21. Apparatus as claimed in Claim 20, including at least 3 friction machines each at a different stage of bran removal for generally separately removing of one of the following groups:

the epidermis and hypodermis layers,
the cross and tube cell layers, and
the seed coat layer.

22. Apparatus as claimed in Claim 21, wherein said abrasion apparatus remove any remaining seed coat layer exterior to a kernel crease and remove the nucellar layer and at least substantially remove the alleurone cell layer.

23. Apparatus as claimed in Claim 22, including additional apparatus which remove the wheat germ by impaction followed by an aspirator operation to separate the germ together with residual bran powder.

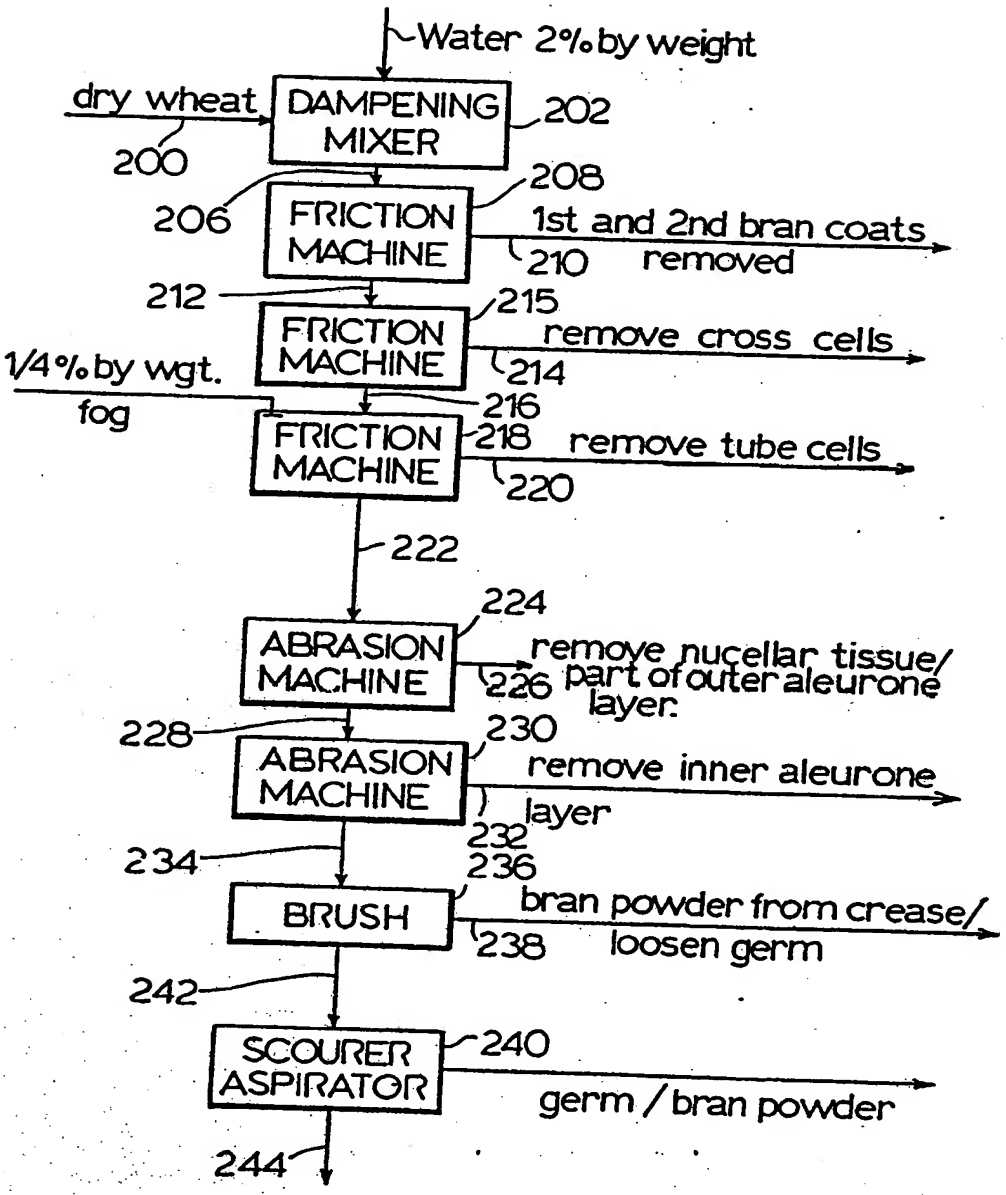
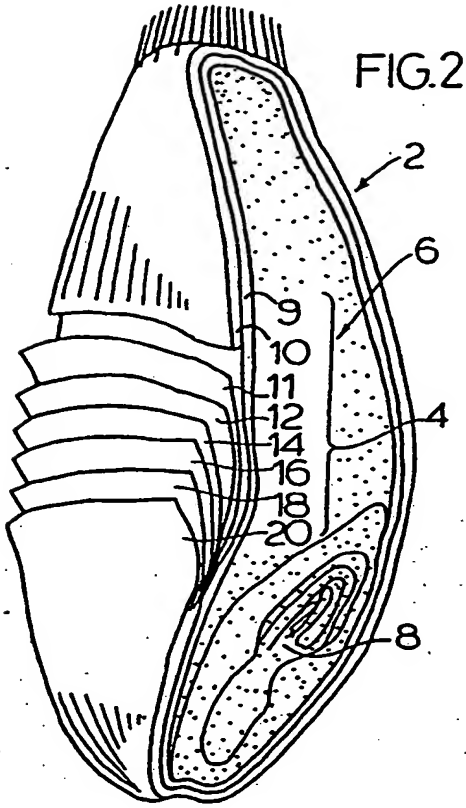

Water 2% by weight
dry wheat
200
DAMPENING MIXER
202
206
FRICTION MACHINE
208
1st and 2nd bran coats removed
210
212
FRICTION MACHINE
215
remove cross cells
214
1/4% by wgt. fog
216
FRICTION MACHINE
218
remove tube cells
220
222
ABRASION MACHINE
224
remove nucellar tissue/ part of outer aleurone layer.
226
228
ABRASION MACHINE
230
remove inner aleurone layer
232
234
BRUSH
236
bran powder from crease/ loosen germ
238
242
SCOURER ASPIRATOR
240
germ / bran powder
244

FIG.1.

FIG.2.



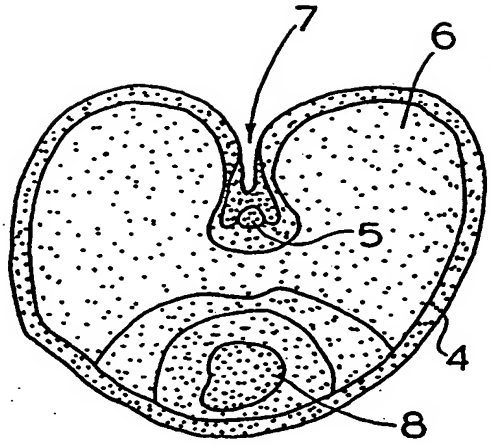


FIG.3.

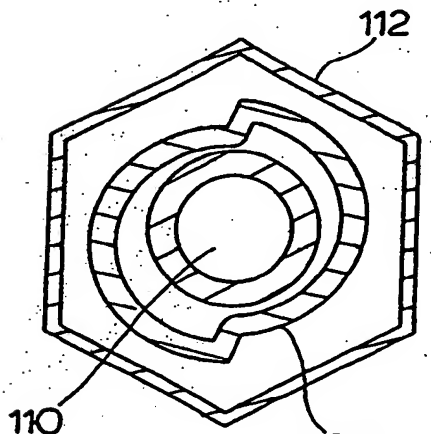


FIG.5.

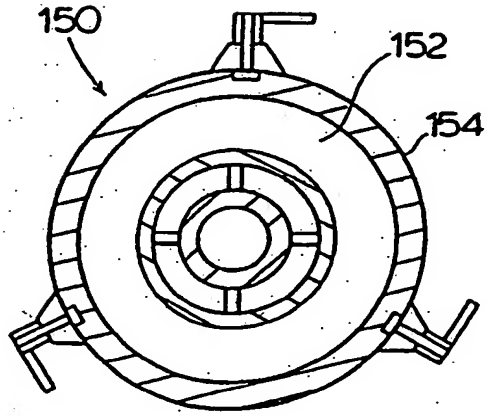


FIG.7.

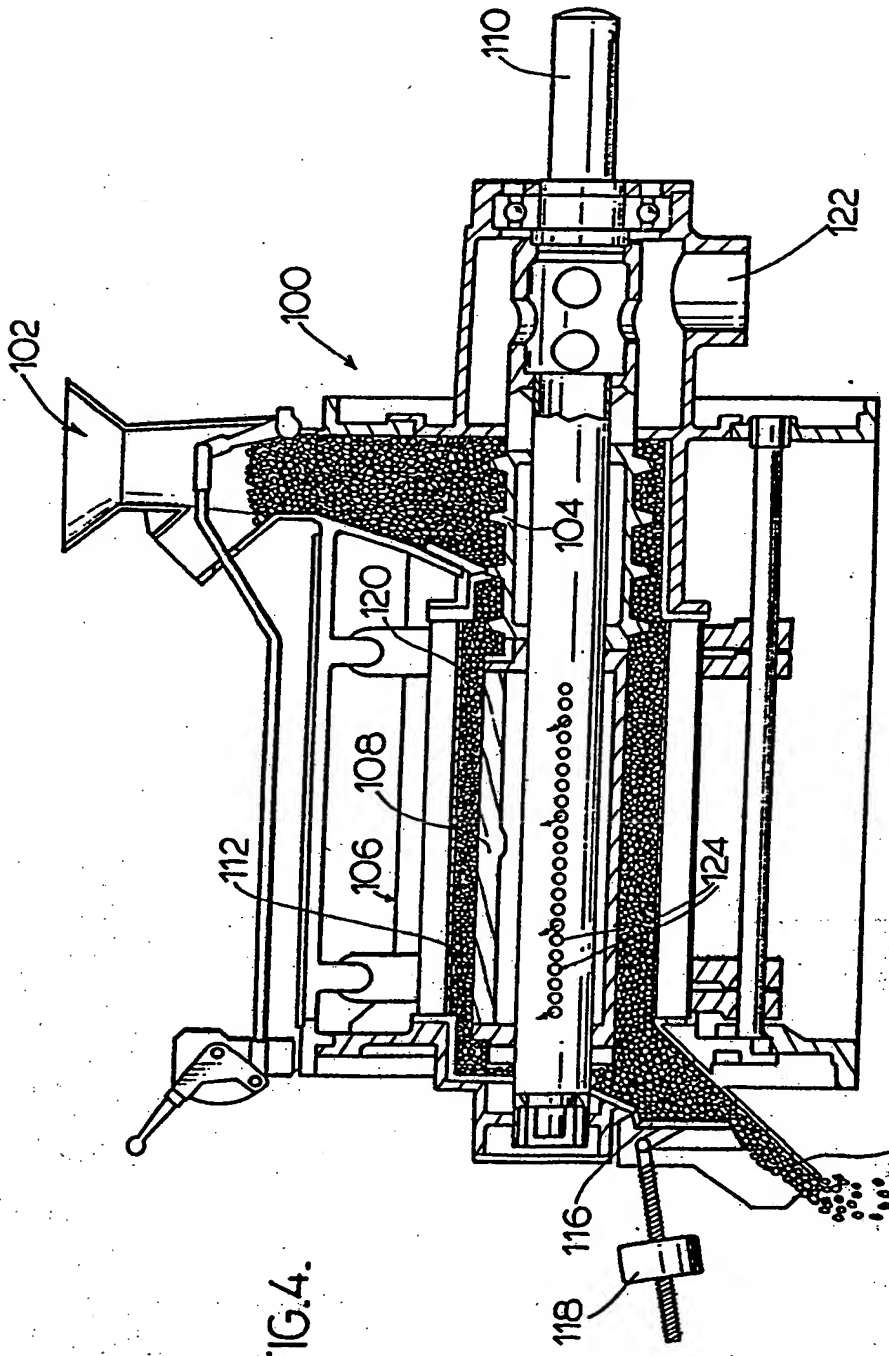


FIG.4.

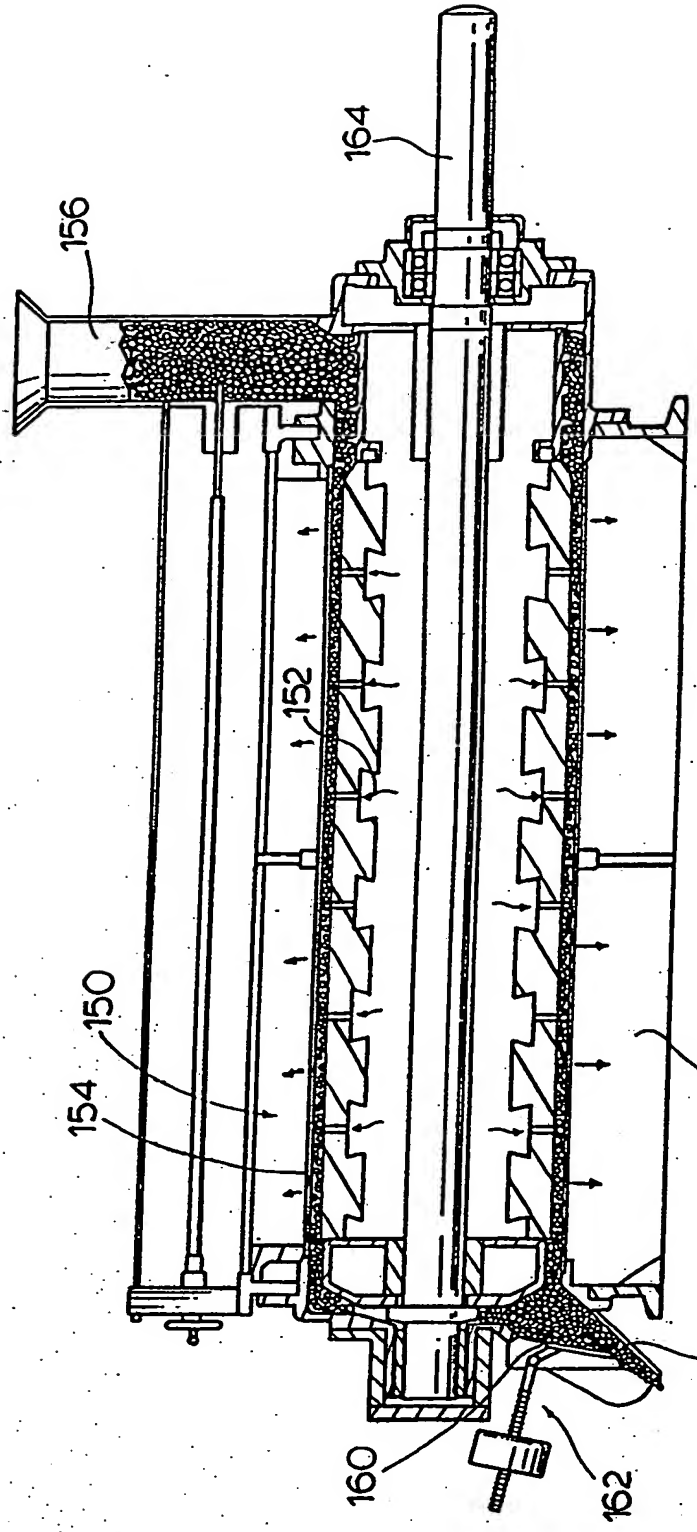


FIG.6.

(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 295 774 A3**

(12) EUROPEAN PATENT APPLICATION

(21) Application number: 88303769.9

(51) Int. Cl.4: B02B 3/04 , B02B 3/00

(22) Date of filing: 27.04.88

(30) Priority: 18.06.87 US 64067

(43) Date of publication of application:
21.12.88 Bulletin 88/51

(84) Designated Contracting States:
AT BE CH DE ES FR GB GR IT LI LU NL SE

(88) Date of deferred publication of the search report:
20.12.89 Bulletin 89/51

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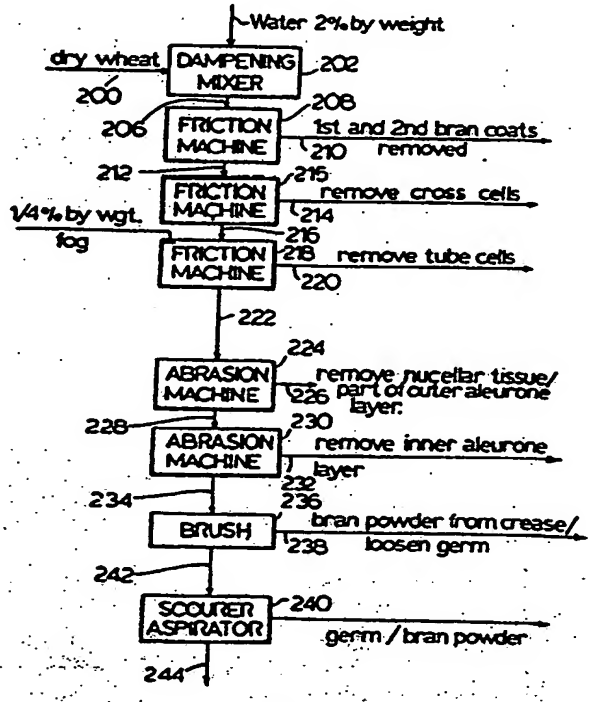

FIG.1.

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European Patent Office

EUROPEAN SEARCH REPORT

Application Number

EP 88 30 3769

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.4)
X	FR-A- 778 710 (DERMY) * Page 1, lines 18-35; page 2, lines 63-95 *	1	B 02 B 3/04 B 02 B 3/00
A		5,14,16-20	
X	DE-A-2 803 527 (SATAKE ENGINEERING CO. LTD) * Page 6, paragraph 3; page 9, paragraph 1 *	1	
A		2,5,14,16-20	
A	EP-A-0 218 012 (SATAKE ENGINEERING CO. LTD) * Column 6, line 32 - column 7, line 30 *	1-3,5-9,14,16-23	
A	CH-A- 640 750 (GEBRÜDER BÜHLER AG) * Abstract; page 5, left-hand column, lines 33-58 *	1-5	

TECHNICAL FIELDS SEARCHED (Int. Cl.4)

B 02 B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	04-08-1989	OECHSNER DE CONINCK S.P.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
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L : document cited for other reasons

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